APPARATUS FOR CONTINUOUSLY TRANSFERRING ORDERLY SEQUENCES OF PREFORMS OF THERMOPLASTIC MATERIAL

DESCRIPTION

The present invention refers to an improved apparatus for handling on a large-scale basis, and in an orderly sequential manner, preforms made of thermoplastic material, in particular polyethylene terephtalate (PET) and polypropylene (PP), adapted to be blow-moulded for conversion into finished containers.

In particular, the present invention can be used in a most advantageous manner when the described apparatus is associated to an integrated type of production plant, ie. a plant that is also known in the art as a single-stage one, but can of course be effectively used also in connection with plants that are fed with previously produced preforms to only carry out the final blow-moulding phase (two-stage plants).

As a matter of fact, these processes for the production of such types of containers are generally known to be able to be schematically divided into two basic topologies, ie. single-stage and two-stage processes.

In two-stage processes, a previously moulded preform or parison in a substantially amorphous state is heated up again to its preferred molecular orientation temperature, at which it is then blow-moulded to the desired shape. As

used this particular context. the term "two-stage process", or simply "two-stage", is intended to mean any process that produces a preform or parison which must subsequently be heated up again from ambient temperature to the respective blow-moulding temperature.

On the contrary, single-stage processes are so defined owing to the fact that they are capable of moulding said so-called preform or parison, transferring the same preform or parison from the injection or extrusion mould (after it has cooled down to some appropriate temperature) to a conditioning station where said preform or parison is allowed to evenly balance down to a preferred molecular orientation temperature. Said preform or parison is then transferred to a blow-moulding mould, where it is moulded into the desired shape.

Both above cited types of production methods involve the use of a (per sè known) blow-moulding station and the therewith associated handling means for transferring and releasing the preforms and/or the blow-moulded containers after the blow-moulding phase. Both types of processes further share the feature of transferring said injection moulded or extruded preforms first to a conditioning and temperature-levelling station and then from this station to the actual blow moulding plant.

Such a transferring operation is usually carried out with the use of various techniques and according to various methods, in particular by contemporaneously transferring groups of preforms to the conditioning station and then, again in a synchronous manner, to the blow moulding unit where said group of preforms is processed simultaneously.

A different technique makes on the contrary use of the concept calling for a plurality of preforms to be first transferred in an orderly, but sequential manner to the conditioning station, where they are treated by allowing them to move in a continuous manner through conditioning ovens or zones. After such a conditioning phase, said preforms are picked on an one-by-one basis and transferred into appropriate blow-moulding tools where they are eventually converted into finished

containers. with a similar process that is however appropriately set to follow an out-of-phase pattern from mould to mould according to the rate of arrival of said preforms.

This second technique has some advantages from both a construction and an operational point of view. as anyone skilled in the art is on the other hand well aware of. so that they shall not be reviewed here.

It however has also a typical drawback connected with the fact that. while the conditioning phase is particularly facilitated by the vertical position of the preform. with the neck portion thereof turned downwards. for largely known reasons. which shall therefore not be recalled here. mounting the preform on the means provided to transfer it first to the conditioning station and then to the blow moulding unit is on the contrary carried out with the preform that. although in a vertical position. has its neck portion turned upwards.

As a result. if use is made of transferring means operating on a single plane. be it a vertical or horizontal one. a serious drawback is incurred in the conditioning phase. if it is opted for the preforms to anyway undergo conditioning with their neck portion turned upwards. or remarkable complications in the construction and. therefore. also the operation of the plant shall be accepted. with a clearly heavy impact on the overall economics thereof. if it is on the contrary opted for such preforms to be transferred with their neck portion turned downwards.

Eloquent disclosures of such a technique making use of transferring means moving on a single plane are described in following patent literature: US 3 984 513. US 4 362 498. WO 89/01400. WO 95/05933. US 3 339 230. US 4 354 813. US 4 313 720. US 4 850 850. EP 0 296 825. EP 0 425 360.

A general temperature conditioning plant for preforms is known from the patent publication FR 2 646 632 to SIDEL to be provided with devices that are capable of reversing the orientation of the preforms twice, so that the same preforms end up by eventually acquiring their initial orientation.

With such devices, the preforms, which reach said temperature conditioning plant with their neck portion facing upwards, are turned upside down, so as to present their neck portion facing downwards, and in such a position they are then subjected to temperature conditioning.

After such a treatment, they are again turned through 180° so as to regain their initial position, ie. with their neck portion facing upwards, which is more favourable in view of the subsequent handling thereof.

However, such devices, which comprise a helical guiding system and roller-type following members, turn practically out to be rather complicated and, therefore, expensive and inherently scarcely reliable, since each preform must be provided with a single device capable of quickly reverse its position on an individual basis.

Based on the above considerations, it is therefore a main purpose of the present invention to provide an apparatus and a method applying to the preform transferring and conditioning phases preceding the actual blow-moulding phase, so as to orientate and change the orientation of the preforms in the most effective, economical and reliable manner, while doing away with the afore cited drawbacks, and to be further capable of feeding the blow moulding plant in a continuous, automatic and orderly manner without any interposition of phases that may interrupt the continuity of the preform feeding flow. Furthermore, such an apparatus must be easily implemented with the use of readily available techniques and means and shall therefore be reasonably low in its overall costs.

Such main aim of the present invention, along with further features thereof, is reached in an apparatus that is made and operates as recited in the appended claims.

The present invention may take the form of a preferred embodiment such as the one that is described in detail below by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a schematical perspective view of an apparatus according to the present invention;

- Figure 2 is a schematical perspective view of two basic components of the present invention, mutually connected as in a real-use situation:

- Figure 3 is a perspective view of the same components of Figure 2, but showing them in a condition in which they are disassociated from each other;

- Figure 4 is a vertical-section view of the conveyor belt, a preform, the respective pick-up plug and support and forward carrying element in correspondence of the preform loading platform;

- Figure 5 is a vertical-section view of the conveyor belt, a preform, the respective pick-up plug and support and forward carrying element in correspondence of the preform heating zone;

- Figure 6 is a schematical perspective view of an improvement of the apparatus illustrated in Figure 1;

- Figure 7 is a schematical perspective view of a further improvement of the apparatus illustrated in Figure 1;

- Figure 8 is a principle vertical side projection of the apparatus illustrated in Figure 1;

- Figure 9 is a principle vertical side projection of the apparatus illustrated in Figure 7;

- Figure 10 is a diagrammatical view of the inner thermal profile across the wall thickness of the preform. for four different thichnesses thereof;

- Figure 11 is a diagrammatical view of two clusters of four curves each, referring to the transient inner and outer temperatures of four preforms having four respective thicknesses;

- Figures 12A, 12B and 12C are side, top and perspective views. respectively, of an apparatus according to an improvement of the present invention. as shown in a particular operating state;

- Figures 13A. 13B and 13C are side, top and perspective views. respectively, of the same apparatus appearing in the above cited Figures. but shown here in a different operating state;

- Figure 14 is a perspective view of a portion of the apparatus shown in Figures 12A and 13A.

The basic peculiarity of the present invention derives from the combined use of a fixed closed-loop conveyor belt. which is adapted to constitute an appropriate transferring guide and whose orientation is defined on two distinct planes. and a chain capable of sliding along said conveyor belt and formed by a plurality of support and forward carrying elements engaged in said guide and on which respective pick-up, accompanying and release members for respective preforms are applied rigidly.

With reference to Figures 1 and 2. these can be seen to illustrate the conveyor or guide belt 2, on which there are mounted two support and forward carrying elements 3, 3a that shall be described in greater detail further on.

The configuration of said conveyor belt. which of course extends to form a closed-loop arrangement, and the elements constituting said chain shall be such as to allow for:

- loading and unloading the preforms 1 associated to said elements 3, 3a to take place with the preforms in a vertical position with their neck portion turned upwards, and the temperature conditioning phase to be on the contrary carried out with the same preforms again in a vertical position, but with their neck portion turned downwards.

Such a result can be obtained if the belt is bent by half round angle at least in a portion thereof on a vertical plane, in such a manner that a preform mounted vertically thereon with a certain orientation, will again be in a vertical position after such a curvature, but with the opposite orientation, ie. turned upside down.

Figure 1 shows that such a result can for example be obtained if the belt 2 is formed by two there-and-back, ie. delivery and return stretches 11 and 12 extending on a horizontal plane and connected to each other by a curved stretch 13 arranged on the same horizontal plane.

In correspondence of said stretches 11 and 12 there is provided at least a conditioning station 6, of a per sè known kind, which heats up and possibly levels off the temperature of the preforms that are moving along said stretches and must therefore be oriented with their neck portion turned downwards. During this conditioning phase, said preforms are automatically caused to rotate on themselves along the vertical axis in order to better distribute the heatung effect, but this fact is largely known in the art and is not a part of the present invention.

On the opposite side of the curved stretch 13, said stretches 11 and 12 continue with two curvatures 14 and 15, respectively, which extend vertically downwards and develop by half a round angle.

At the end of such curvatures 14 and 15, the preforms, which remain associated to the belt with the aid of means that will be described in greater detail further on, will undergo themselves a rotation by half a round angle, so as to eventually assume an orientation with their neck portion turned upwards.

At this point, the two vertical stretches 14 and 15 can be joined to each other by an at least partially curved horizontal stretch 16 along which the stations 4 and 5 for respectively loading and unloading the preforms onto and from said conveyor belt can therefore arranged, wherein said preforms do not change their orientation.

The two stretches 14 and 15 can of course be curved at their upper portion, instead of being so curved at their lower portion as shown in Figure 1. It will be similarly appreciated that a number of other physical configurations are also possible using in all cases the teachings of the present invention. Anyway, since such configurations can be quite readily conceivable by those skilled in the art on the basis of such teachings, they shall not be illustrated here for the sake of brevity.

As far as the support and forward carrying elements 3, 3a and the therewith associated pick-up plugs 7 are concerned, reference should be made to Figure 2 , which is a perspective view of said elements 3 and 3a in a connected state, as well as to Figure 3, which is a disaggregated view of some components of the present invention.

The support element 3 is constituted by a central body that is provided, on one of the onward motion sides, with two parallel tabs 20 and 21 featuring two appropriate respective holes 22 and 23 arranged on the same axis X.

On the opposite side of these tabs there is provided a protrusion 25 featuring a through-hole 26 that has its own axis Y orthogonal to said axis X.

The architecture, the geometry and the dimensions of said support element 3 are such that, when combined with a further support element 3a similar to said first element 3, the tabs 20a and 21a thereof define a niche adapted to accomodate the protrusion 25 of said element 3, and a pin 27 is in turn capable of being engaged between said through-hole 26 and the holes 22a and 23a provided in the respective tabs of said further element 3a.

Figure 2 illustrates a pair of such contiguous support elements 3, 3a connected in series and necessarily rotated at 90° with respect to each other so as to allow for their mutual connection that is obtained by means of said protrusion 25 of one of said elements engaging a respective niche of the contiguous element. Such a method of connection of contiguous support elements to each other repeats itself in a similar manner in connection with all remaining support elements in the arrangement.

At this point, anyone skilled in the art is capable of readily appreciate that said elements 3, 3a can be connected in series so as to form a closed-loop chain that has the peculiarity of being capable of being driven, ie. moved along an appropriate guide belt that can extend to develop into a three-dimensional path, in particular a path as illustrated in Figure 1, by taking advantage of the circumstance that each support element 3 is capable of freely rotating by 90° with respect to an axis of a contiguous element 3a situated on a side thereof, and is also capable of freely rotating, again by 90°, but about an axis that is orthogonal to the just above mentioned axis, of a further contiguous element situated on the other side of the element 3 with respect to the element 3a.

A chain is in this way obtained, in which each link, or support element 3, is substantially similar to any other link, and in which contiguous links are mounted with a mutually orthogonal orientation, so that said chain is capable of being moved with respect to a guide belt extending along any three-dimensionally configured path.

In particular, such a chain is capable of sliding, and therefore being driven, along the belt illustrated in Figures 1, 6 or 7. For said chain to be used to the purposes of the present invention, each support element 3, 3a is provided with a respective fastening means 30, 30a connecting the support element to a so-called pick-up plug 31 and 31a or similar member capable of picking up, keeping in a defined position and finally releasing a respective preform 32, 32a. The technology of such pick-up plugs or similar means, the purpose thereof, their operation and use are well known in the art, so that they shall not be illustrated here.

If such pick-up plugs are connected with respective support elements, possibly with the aid of auxiliary coupling supports, a configuration is obtained as illustrated in Figures 1 and 3, ie. a closed-loop chain whose elements 3 are linked to respective pick-up plugs, to which respective preforms are in turn associated.

It is therefore clear, and demonstrated, that such a chain and all elements thereof are capable of freely moving along the three-dimensional path illustrated in the Figures owing to the fact that, in each pair of contiguous support elements, these are capable of rotating by 90° on a specific plane since they are hinged on a common axis Y. The same applies also to the contiguous and external support elements on the opposite sides of said pair of elements, which are actually capable of again rotating by an angle of 90°, but on a plane that is orthogonal to the above cited specific plane since they are hinged on respective axes situated on said orthogonal plane, of which one is represented by the axis X in Figure 2.

Said guide belt and said chain of support elements, developing into a closed-loop configuration, are configured so as to be able to transfer, by means of said pick-up plugs and therewith associated coupling elements, the plurality of preforms along a path that has at least a horizontal, even curved stretch 16, in which said preforms are oriented with their neck portion turned downwards and which can therefore accomodate the preform loading and unloading stations 4 and 5, as well as at least a different horizontal stretch 11 or 12 in which said preforms are oriented with their neck portion turned upwards, ie. in the best possible position in view of undergoing the temperature conditioning treatment.

Reference should be made to Figure 8 to better understand the basic configuration of the apparatus illustrated in Figure 1, emphasizing the positions of the preform loading and unloading stations 4 and 5, the horizontal stretches 11 and 12 that accomodate the position of the conditioning station 6, the horizontal curved stretch 13 that joins said horizontal stretches to each other, as well as the vertical stretches 14 and 15 that are provided to turn the preforms upside down.

Figures 4 and 5 illustrate two opposite positions of the preform 7 and the therewith connected members. In fact, while Figure 4 illustrates the preform in the vicinity of the loading and unloading station, where it is in a vertical position, but with its neck portion 51 turned upwards, the respective pick-up plug and support element 3 being in turn consistently oriented with respect to the belt 2, Figure 5 illustrates the preform in a point along the heating or conditioning stretch 6 in which it still is in a vertical position, but with its neck portion 51 turned downwards, while even in this case the respective pick-up plug and support element can be seen to be of course reversed with respect to their position in Figure 4.

As far as the method used to drive said chain of support elements along said guide belt is concerned, the same can be implemented through the use of appropriate driving means that are generally known in the art. In particular, and advantageously, in the solution exemplified in Figures 3, 4 and 5, such a driving motion is implemented by engaging appropriate latching means 34 and 35 provided at the ends of said pins 27 connecting contiguous support elements, as this has already been described above.

Said latching means 34 and 35 are illustrated also in Figure 4, which shows a vertical-section view of the preform, the related pick-up plug 31, the related support element 3, and the related latching means 34 and 35, in a position in which the preform is turned with its neck portion facing upwards, ie. in the vicinity of the loading and unloading station.

Also visible in said Figure 5, namely in the dashed portion 28 thereof, is the section of the guide belt 2 that accomodates, and therefore guides, the latching means 34 and 35. In general, the guide belt 2 and the associated chain of support elements are shown in Figures 4 and 5, in the sense that, typically, the configurations appearing in said two figures are exhaustive of the totality of the extension and development of the apparatus, ie. where there is provided the driving device (Figure 4), no guide belt is on the contrary provided, and vice-versa (Figure 5).

The driving means 36 engaging said latching means 34 and 35 is schematically illustrated in Figure 4 and may consists of a traditional means like a gearwheel.

The present invention also allows for an adbvantageous improvement, which proves particularly useful in view of making the plant even more compact. In fact, with reference to Figure 6 it can be noticed that the belt can enable at least two further horizontal stretches 16a and 16b to be included within the stretch 16, along which at least a part 6a, 6b of the elements of the conditioning station 6 can in this way be arranged so that this same conditioning station can actually be subdivided into a plurality of separate and distinct portions. This offers the possibility for the temperature conditioning function that such a station is called to perform to be varied according to actual needs and possibly optimized.

A further improvement is illustrated in Figures 7 and 9. In fact, considering that the preform heating phase taking place there is usually followed by a phase in which the temperature of the same preforms is levelled off, it turns out to be of advantage if said temperature levelling-off phase is carried out, of course immediately after said heating phase, along a stretch 70 provided as an extension of the horizontal stretch 12 and related chain.

Such an extension stretch 70 terminates of course with a vertical curved reversing stretch 71, which corresponds to the afore mentioned stretch 14 of the plant shown in Figure 1, before joining again said at least partially curved stretch 16 via a horizontal connecting stretch 72.

In practice, the plant shown in Figure 1, where it appears to be substantially symmetrical, is in this way modified so as to solely lose its symmetry, owing to said extension 71, in connection with said stretch 12 along which said conditioning station 6 may be situated even partially, said extension 71 having no other function except the task of enabling the temperature of the preforms to appropriately level off before the preforms themselves are unloaded from the apparatus in order to be delivered to the subsequent blow moulding station.

The adopted solutions, although advantageous and fully feasible as far as their practical implementation is concerned, must however cope with a problem of productivity of the whole plant, namely with a problem of optimization of the productivity of the plant when conditioning preforms that may differ even significantly from each other as far as their thickness is concerned.

A more detailed explanation of the causes behind such a problem is given below:

- it is generally known that, when leaving conditioning stations, preforms usually feature a temperature that is lower on their inner surface than the temperature prevailing on their outer surface, owing to commonly known reasons that do not need to be dealt with once again here;

- it is also generally known that carrying out the actual blow moulding phase requires optimal temperatures to prevail on both surfaces of the preforms; in particular it requires that the inner temperature be higher than or at least equal to the temperature on the outer surface, ie. a requirement that clearly clashes with the above described temperature condition of the preforms as they leave the conditioning station;

- it is further generally known that, in view of obtaining optimum temperature values on both inner and outer surfaces, said conditioning phase is allowed to be followed by a "temperature levelling-off" phase consisting in a period of time during which heat is neither delivered to nor removed from the preforms themselves, so that temperatures spontaneously tend to become equal or even reverse during this period (inversion time); however, the actual profile of such spontaneous temperature variations depends on a number of factors, among which there is of course the duration of the levelling-off phase, the temperatures prevailing at the beginning of this phase, as well as other influential parameters, such as in particular the thickness of the preforms themselves.

In practice, at the end of said levelling-off phase the inner and outer temperatures of the preform reach values that depend on the above cited construction and physical parameters concerning not only the preforms themselves, but also the plant and the process.

For a better explanation and understanding of the above point, reference should further be made to Figures 10 and 11. In the diagram appearing in Figure 10, the temperatures prevailing on the inner thickness surface of four preforms having different thicknesses (duly indicated in said Figure) at the end of the temperature levelling-off phase are plotted in the ordinate. More precisely, each curve in said diagram shows the temperature of each inner point of the preform situated at a distance from the outer as indicated by the corresponding values in the abscissa. As a result, the temperatures that correspond to the value 0 in the abscissa are practically the temperatures on the outer surfaces of the respective preforms, whereas the temperatures that correspond. on the abscissa, to the terminal points F, G, H, J are the temperatures on the respective inner surfaces of the four preforms.

It should be noticed that the final temperatures tend to decrease with an increasing thickness of the preform, ie. a fact that can be explained in that the more the thickness increases, the more the heat finds it difficult to diffuse through the preform.

Therefore, in order to have a relatively constant temperature the need would arise for as specific levelling-off time to be defined and complied with for each preform thickness.

Still more clear and visible is this fact when looking at Figure 11 which shows:

- the outer temperatures, as defined by four curves indicated with the letters f, g, h, j and collected into the sheaf of curves indicated as "Group 1" in the Figure,
- and the inner temperatures, defined by four further respective curves indicated with the use of the same letters as above (since they refer to the same preform), and collected into the sheaf of curves identified as "Group 2" in the

Figure. of four preforms f. g. h, j having respective different thicknesses of 3.0, 3.5, 4.0 and 4.6 mm.

What can actually be inferred from this diagram is that the temperature inversion point. ie. the moment at which. during the levelling-off phase, the decreasing outer temperature reaches down to the value of the contemporaneously increasing inner temperature, is identifiedin the instant indicated at A and occurring after approx. 35 seconds for the thinnest preform f, ie. the one with a thickness of 3.0 mm, wheras the inversion point for the thickest preform j, ie. the one with a thickness of 4.6 mm, is reached after as many as approx. 47 seconds, at the instant identified as B in the Figure, with an increase of approx. 12 seconds in the levelling-off time required.

In the diagram appearing in the same Figure it can also be verified that the inversion points preforms with intermediate thickness values are reached after periods of time that are of course comprised between the above cited minimum and maximum duration.

In connection with the above cited Figure 11 it should be further explained that the two peaks reached by the temperatures at Q and W along the evolution curve thereof depend on the fact that the conditioning process is carried out in two distinct and subsequent phases, that are separated from each other by a short time interval, to the purpose of being able to deliver the total required amount of heat, without anyhow causing the outer temperature of the preforms to rise to any excessive extent.

Since construction and process parameters are generally pre-set and defined at the actual design engineering stage, so that they prove usually difficult, if not impossible to modify during production, it ensues that these can be harmonized and purposedly set in view of optimizing the overall result, ie. not only as far as the quality of the preforms is concerned, but also in strictly production-related terms, solely for a particular type of preforms, so that the result that will be obtained for any other type of preforms will unavoidably be a just acceptable compromise.

In fact, if preforms of a certain, relatively thin thickness are used, all other plant and process parameters remaining unaltered, said temperature inversion time will have a given duration; if preforms with a considerably greater thickness are however processed in the same plant, then the respective inversion time, required to bring these preforms to the desired blow moulding conditions, will increase accordingly, as this has been documented above. However, for such an increase in the inversion time to be brought about, the need arises, considering the constancy of the dimensions of the plant, for the speed at which the preforms are moving along to be reduced, with the result of a proportionately reduced productivity of the same plant.

In view of doing away with such a drawback, mention is made here again of the fact that, according to the present invention, the plant of the invention also comprises the horizontal stretch 12 that may be extended by an additional stretch 70 in order to enable the preforms to undergo a temperature levelling-off upon leaving said horizontal stretch 12.

The present improvement relates to the possibility for the geometry of the closed-loop belt carrying the pick-up plugs to be varied, albeit with following limitations:

- the overall length of the belt remains unaltered, so that the same belt can be used even without the present improvement,

- the arrangement of the horizontal stretches on the two distinct parallel horizontal planes (two stretches per plane and, therefore, four horizontal stretches in total) remains substantially unaltered, except for what will be set forth further on;

- the two curved stretches 13 and 16 arranged on the two horizontal planes and connecting the two pairs of said four horizontal stretches remain unaltered.

The improvement lies in the possibility for two horizontal stretches to be extended in their length downstream of a conditioning station and, as a result,

another stretch situated on a different parallel horizontal plane to be made shorter, so as to make it possible for a variable-length overall path and, therefore, for the same forward moving speed of the belt, a variable temperature levelling-off time to be obtained before the preeforms are allowed to reach their unloading station.

With reference to the set of Figures 12 and 13, Figure 12C can in particular be seen to illustrate an arrangement in which along two horizontal stretches situated on the same plane there are provided two distinct conditioning stations 60 and 61 that are associated to the two belt stretches 12 and 11, respectively.

In order to be able to join said horizontal stretch 12 to said curved stretch 16 situated on a parallel plane, a stretch 14 curved by half a round angle on the vertical plane is provided.

It should further be noticed that, upon turning by said half a round angle on the vertical and having so moved onto the lower parallel horizontal plane, the preforms practically do not need to move along, ie. cover any further stretch, since they are immediately intercepted by the unloading station 5 arranged at the beginning of said curved horizontal stretch 16.

It should also be noticed that, upon being loaded at the loading station 4, the preforms must move along the two horizontal stretches 110 and 111, which are situated on the two parallel plane, and the vertical curved stretch 15 that joins them to each other.

However, when so moving along this path, the preforms do not undergo any conditioning and/or treatment of any kind, so that the actual length of said stretches 110, 15 and 111 has no relevance to treatment purposes and, therefore, does not affect the properties of the preforms.

With the illustrated arrangement, therefore, the preforms are practically picked up by the unloading station 5 almost immediately upon the conclusion of the conditioning treatment in the conditioning station 60.

In the illustration appearing in Figure 13C it can be noticed that the apparatus shown there is substantially similar to the one illustrated in Figure 12C, however with following differences, ie. modifications with respect thereto:

- the first modification refers to the path followed by the belt from the exit of the conditioning station 60 to the entrance into the unloading station 5: whereas in the case of the apparatus in Figure 12C such a pathmerely comprises the curved stretch 101, in the case of the apparatus of Figure 13C this path also includes:

- a rectilinear horizontal stretch 121 that follows said conditioning station 60 and immediately precedes said curved stretch 14,

- a second rectilinear horizontal stretch 131 that immediately follows said curved stretch 14 and precedes said unloading station 5.

It will be readily appreciated that, since the conditioning station 60 and the unloading station 5 keep their position in relation with each other owing to them being firmly joined to the same carrying structure, the length of said added stretches 121 and 131 must be the same.

Owing exactly to such a reason, as well as to the constancy of the mutual positions of the curves stretches 13 and 16 and the conditioning stations 60 and 61 in relation with each other, and finally also due to the constancy of the overall length of the closed-loop belt acting as a guide for the preform pick-up plugs, it ensues that the lengths of the afore described stretches 110 and 111 are nullified.

In fact, owing to the length of the belt being constant, any modification in the development thereof in a given stretch makes it necessary for its development in another stretch to be modified accordingly; and since the stretches that can be modified are only the ones that are not affected by said curved stretches 13 and 16 and the conditioning stations 60 and 61, it ensues as a logical consequence that said pairs of stretches 110 and 111 (illustrated in a limiting configuration thereof), and the

stretches 121 and 131 (in the opposite limiting configuration), can compensate each other, of course within the limits as set and described above.

It is therefore possible, and obvious, for supplementary stretches 121 and 131 to be inserted between the conditioning station and the unloading station, so that said supplementary stretches are then able to enable the time to extended during which the preforms are allowed to level off their temperature before reaching the unloading station, since the forward moving speed of the belt remains constant.

On the other hand, it also appears quite obvious that such a possibility for then length or duration of said supplementary temperature levelling-off time to be modified must be appropriately calibrated in accordance with the actual needs, which depend on a number of factors, such as mainly the speed of the belt, the thickness of the preforms and the desired extent of levelling-off, as this has already been discussed earlier in this description.

It therefore is of paramount importance to be able to rely on the possibility for said temperature levelling-off time to be modified, between the conditioning station and the unloading station, within two pre-settable limit values, wherein said levelling-off time can of course be varied by accordingly modifying the length of said variable-length stretches 110, 111 and 121, 131 with respect to each other.

Such a possibility can be brought about through the use of such a device 140 as illustrated symbolically in the Figures and in particular in Figure 14. This device comprises:

- two actuation rods 140 and 141 which in a preferred manner are threaded externally and are capable of engaging respective blocks 142 and 143 associated to the guides 144 and 145 that lead said belt into said curved stretches;

- an actuation member 146 adapted to cause said actuation rods 140 and 141 to rotate contemporaneously, possibly through a belt-like or chain-like connecting means or similar appropriate means 147; wherein said rods 140, 141, said actuation

member 146 and said connecting means 147 for transmitting the actuation to said rods are firmly joined to said common structure carrying the curved stretches 13 and 16 and said conditioning stations.

At this point of the description, anyone skilled in the art is fully capable of readily understand how the apparatus according to the present invention actually operates: in fact, after setting the apparatus for a given type of preforms, a defined forward moving speed of the conveyor belt, as well as a certain temperature levelling-off time (which is in turn dependent on the desired temperature variations), it becomes readily possible for the overall length, and therefore the length of the individual variable-length stretches 121 and 131, to be calculated and said actuation member 146 to be then acted upon so as to enable said blocks 142 and 143 to correspondingly slide with respect to the respective actuation rods 140 and 141. Owing to the afore cited fact that such actuation rods are firmly associated spatially with the structure of the plant and that said blocks are linked to the respective guides 144, 145, the result is a displacement of said blocks, and therefore the respective guides, with respect to the structure itself of the plant. This leads to a corresponding variation in the overall development geometry of the conveyor belt carrying the preform pick-up plugs and in particular, in a case, a prolongation of the stretches 121 and 131 and a corresponding shortening of the stretches 110 and 111, since the overall length of the belt is constant; in the opposite case, shorter stretches 121 and 131 will correspond to similarly longer stretches 110 and 111.

From the above description and the various examples set forth therein the possibility becomes readily apparent for the various stretches making up the guiding belt to be so redistributed as to obtain an overall length of the stretches 121 and 131 adapted to be covered by the preforms in a period of time that corresponds to the actual levelling-off time desired.

The above described improvement therefore enables the possibility to be most easily brought about for a same preform conditioning and temperature levelling-off apparatus to be most readily, simply, economically used in connection with

preforms that may differ even to a considerable extent from each other, without any particular implementation-related difficulty.

Those skilled in the art will also be readily able to appreciate that the above embodiments have been described and illustrated in a symbolical manner, since embodiments can be readily imagined that may be even more respondent to usual construction standards. In particular, the actuation member 146 may be advantageously obtained in a motor appropriately adapted to be controlled by means of feedback signals that are indicative of the position of the blocks 142 and 143; such a position of said blocks may of course be determined even independently through autonomous controls, provided that the afore cited constraints and limits are duly complied with.

Although the invention has been described here based on the example of preferred embodiments thereof and using a generally known terminology, it shall not be intended as being limited thereby, since it is well within the ability of anyone skilled in the art to develop a number of variants from the teachings thereof. The appended claims shall therefore be understood as covering all such possible obvious modifications that are within the ability of those skilled in the art and do not depart from the actual scope of the present invention.

CLAIMS

1. Apparatus for continuously transferring orderly sequences of preforms (1) adapted to be converted into finished containers, comprising at least a closed-loop conveyor belt (2) that constitutes guiding means for a closed-loop moving conveyor chain, which is adapted to be driven into a continuous motion and comprises a plurality of support and forward carrying elements (3, 3a) capable of carrying respective preforms, a loading station (4) for loading in said preforms, an unloading station (5) adapted to separate said preforms from said elements, at least a temperature conditioning station (6) provided between said loading and said unloading station for treating the preforms as they are carried on said elements, means for carrying forward said support and forward carrying elements along said closed-loop belt, said support and forward carrying elements being provided with respective pick-up plugs (7) to pick up, accomodate and release respective preforms, characterized in that

- said loading and unloading stations are arranged so as to enable the preforms to be loaded onto the pick-up plugs, and released therefrom, in a vertical position with their neck portion turned upwards,

- said support and forward carrying elements (3, 3a) are rotated as they move along from said loading station to said unloading station so that, when they move through said temperature conditioning station (6), the respective preforms are positioned vertically with their neck portion turned downwards.

2. Apparatus according to claim 1, characterized in that said belt comprises:

- two horizontal, preferably rectilinear, parallel stretches (11, 12) connected to each other by a curved stretch (13) which is arranged on the same horizontal plane and connects two corresponding end portions of said parallel stretches..

- two stretches (14, 15) curved by an arc of half a round angle and situated on two vertical planes, in which each one of these two curved stretches (14, 15) extends into a respective horizontal, preferably rectilinear stretch (12, 11),

- an at least partially curved stretch (16) situated on a horizontal plane and joining the end portions (14a, 15a) of said two stretches (14, 15) curved by an arc of half a round angle each.

3. Apparatus according to claim 1, characterized in that said belt comprises:

- two horizontal, preferably rectilinear, parallel stretches (11, 12) connected to each other through a curved stretch (13) situated on the same horizontal plane and joining two corresponding end portions of said parallel stretches.

- in which one of said horizontal stretches (12) is provided with an extension stretch (70) adapted to allow the preforms leaving such horizontal stretch (12) to undergo a temperature levelling-off phase,

- two stretches (71, 15) that are curved by an arc of half a round angle and are situated on two vertical planes at the end of said first stretch (11) and said extension stretch (70), respectively,

-an at least partially curved stretch (16) situated on a horizontal plane and joining the end portions (14a, 15a) of said two curved stretches (71, 15).

4. Apparatus according to claim 2 or 3, characterized in that said support and forward carrying elements (3, 3a) are mutually linked so as to form a closed-loop chain and are alternately connected and oriented by an angle of 90°

5. Apparatus according to claim 4, characterized in that all of said support and forward carrying elements (3, 3a) are similar.

6. Apparatus according to any of the preceding claims, characterized in that said loading and unloading stations (4, 5) are arranged along said at least partially curved stretch (16) situated on a horizontal plane.

7. Apparatus according to any of the preceding claims, characterized in that

- said support and forward carrying elements (3, 3a) are provided with coupling means (20, 21) adapted to be hinged on according an axis X, and further coupling means (25) adapted to be hinged on according to an axis Y, in which said coupling means (20, 21; 25) are arranged on the opposite sides of the same support element (3),

- said hinging-on axes X, Y are orthogonal to each other,

- said support and forward carrying elements are capable of being joined to each other by means of respective coupling means and appropriate respective pins (27).

8. Apparatus according to claim 7, characterized in that

- said coupling means (20, 21) comprise tow parallel tabs provided with respective appropriate holes (22, 23), adapted to be engaged by a pin inserted in said holes according to the axis X,

- said further coupling means (25) comprises a protrusion provided with a through-hole (26) having its respective axis Y orthogonal to said axis X.

- a further support element (3a), similar to said first support element (3), is adapted to insert the respective protrusion (25) within the niche that is defined by said tabs (20. 21) of said element (3),

- a pin (27) is adapted to be engaged between said through-hole (26) of said protrusion and the holes provided in the respective tabs of said further support element (3a).

9. Apparatus according to claim 8, characterized in that said support and forward carrying elements are rigidly associated to respective pick-up plugs (31, 31a) or similar members (30, 30a) adapted to retain respective preforms (32, 32a).

10. Apparatus according to any of the preceding claims, characterized in that said support and forward carrying elements are provided with latching means (34, 35) capable of being engaged by respective hauling means adapted to drag said support and forward carrying elements along the whole closed-loop path of said guiding conveyor belt (2).

11. Apparatus according to claim 10, characterized in that said belt is oriented in such a manner that along said two horizontal, preferably rectilinear stretches (11, 12) the preforms are positioned with their neck portion turned downwards, wherein said temperature conditioning station (6) is arranged at least partially along one of said two horizontal stretches (11, 12).

12. Apparatus according to any of the preceding claims 2 to 9, characterized in that said at least partially curved stretch comprises at least a rectilinear stretch (16a, 16b), and that at least a portion (6a) of said conditioning station (6) is arranged in correspondence of said at least a rectilinear stretch (16a, 16b).

13. Apparatus according to any of the claims 10 to 12, characterized in that said latching means (34, 35) are provided at the end portions of the parallel pins (27), whose respective axes Y are parallel to the axis of the preforms (32, 32a)

corresponding to the pair of contiguous support elements (3, 3a) connected by said pin (27).

14. Apparatus according to any of the claims from 2 on, characterized in that said said chain is moved forward by driving means, comprising preferably a gearwheel, which act on said chain solely in correspondence of said curved, preferably horizontal stretches (13), that in the curved stretch where said driving means are so acting said guiding belt (2) is interrupted, and that where there is provided said guiding belt no such driving means are on the contrary provided.

15. Apparatus according to any of the claims from 2 on, characterized in that said closed-loop belt (2) is adapted to take a variable configuration with respect to said conditioning stations (60, 61) and said curved stretches (13, 16), so as to enable a variable-length path to be obtained between the last conditioning station (60) and the preform unloading station, wherein said closed-loop belt maintains a constant overall length.

16. Apparatus according to claim 15, characterized in that said variable-length path is given by the sum of two distinct variable-length paths (121, 131).

17. Apparatus according to claim 16, characterized in that one (121) of said two variable-length paths is provided downstream of said last conditioning station (61) and before said vertical curved stretch (14), and the other one (131) of said two paths is provided downstream of said same vertical curved stretch (14) and ahead of said unloading station.

18. Apparatus according to claim 17, characterized in that said two variable-length paths (121, 131) can take a minimum length amounting substantially to nothing.

19. Apparatus according to any of the claims from 16 on, characterized in that said two variable-length paths (121, 131) have each time the same length.

20. Apparatus according to any of the claims from 16 on, characterized in that there are provided actuation means adapted to cause said two distinct variable-length paths to be lengthened or shortened, in which said means comprise:

- two actuating rods (140, 141),

- two blocks (142, 143) capable of respectively engaging said actuating rods and linked to respective guides (144, 145) supporting said vertical curved stretches (14, 15) so that the variation in the length of said two paths (121, 131), which are arranged on the opposite sides of said vertical curved stretch (14), is compensated for by a corresponding length variation in the two stretches (110, 111) of said belt arranged on the opposite sides of the vertical curved stretch (15) preceding said conditioning station (61).

21. Apparatus according to claim 20, characterized in that said means further comprises an actuation member (146) adapted to convey a synchronous rotation to said actuating rods (140, 141) so that these can cause the respective blocks to be displaced with respect to a structure that is firmly joined to said horizontal curved stretches (13, 16) and said conditioning stations.

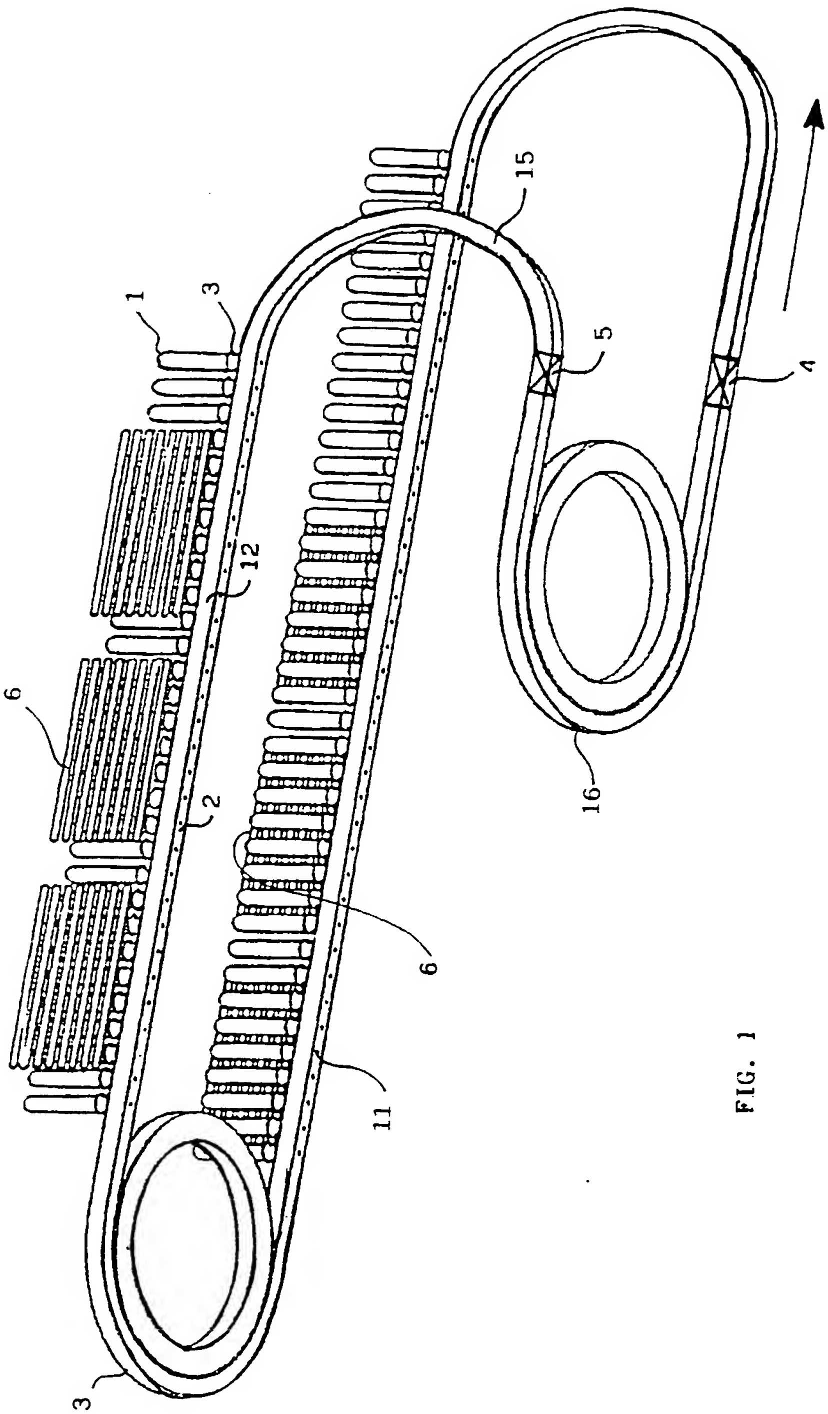


FIG. 1

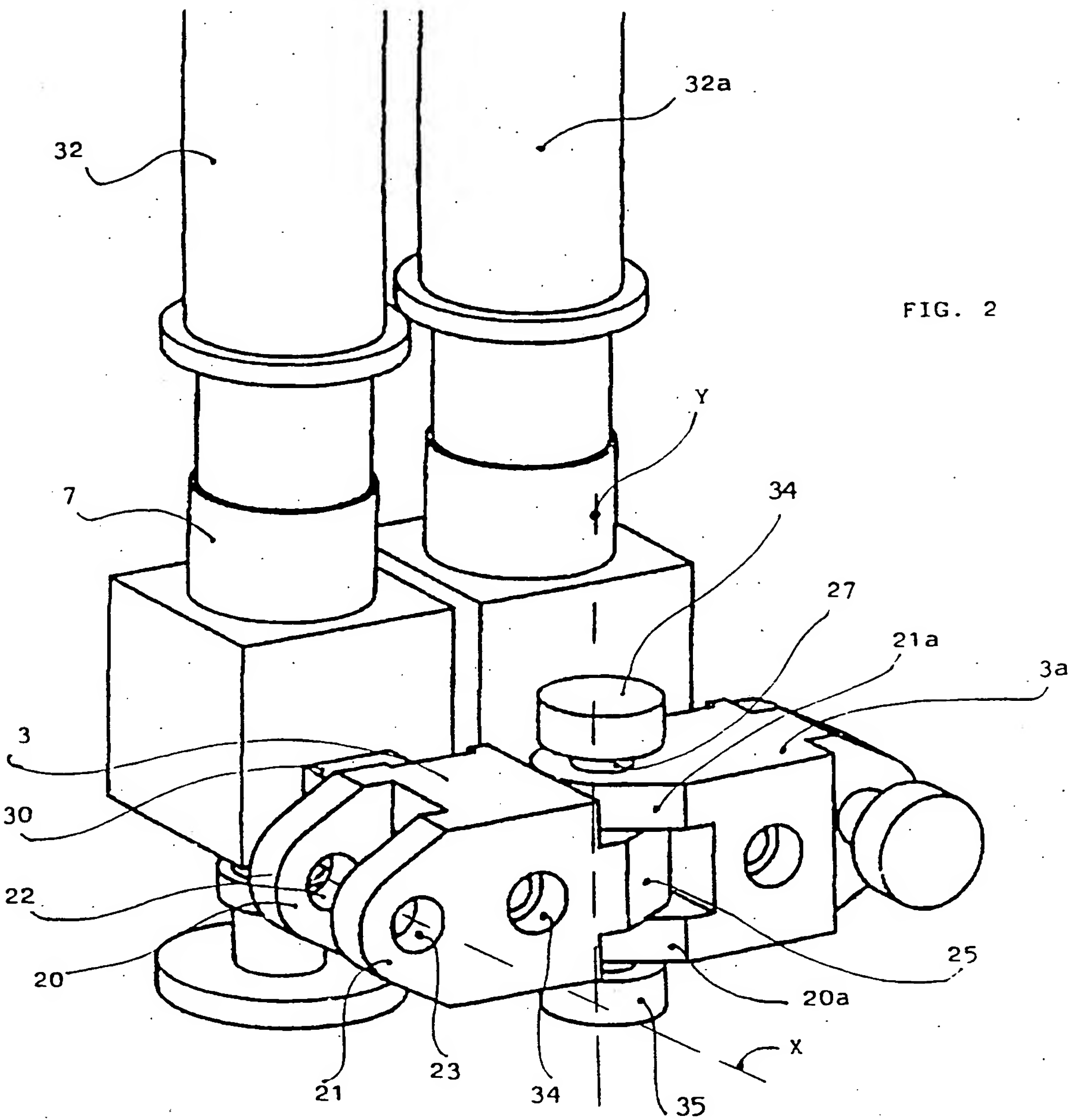


FIG. 2

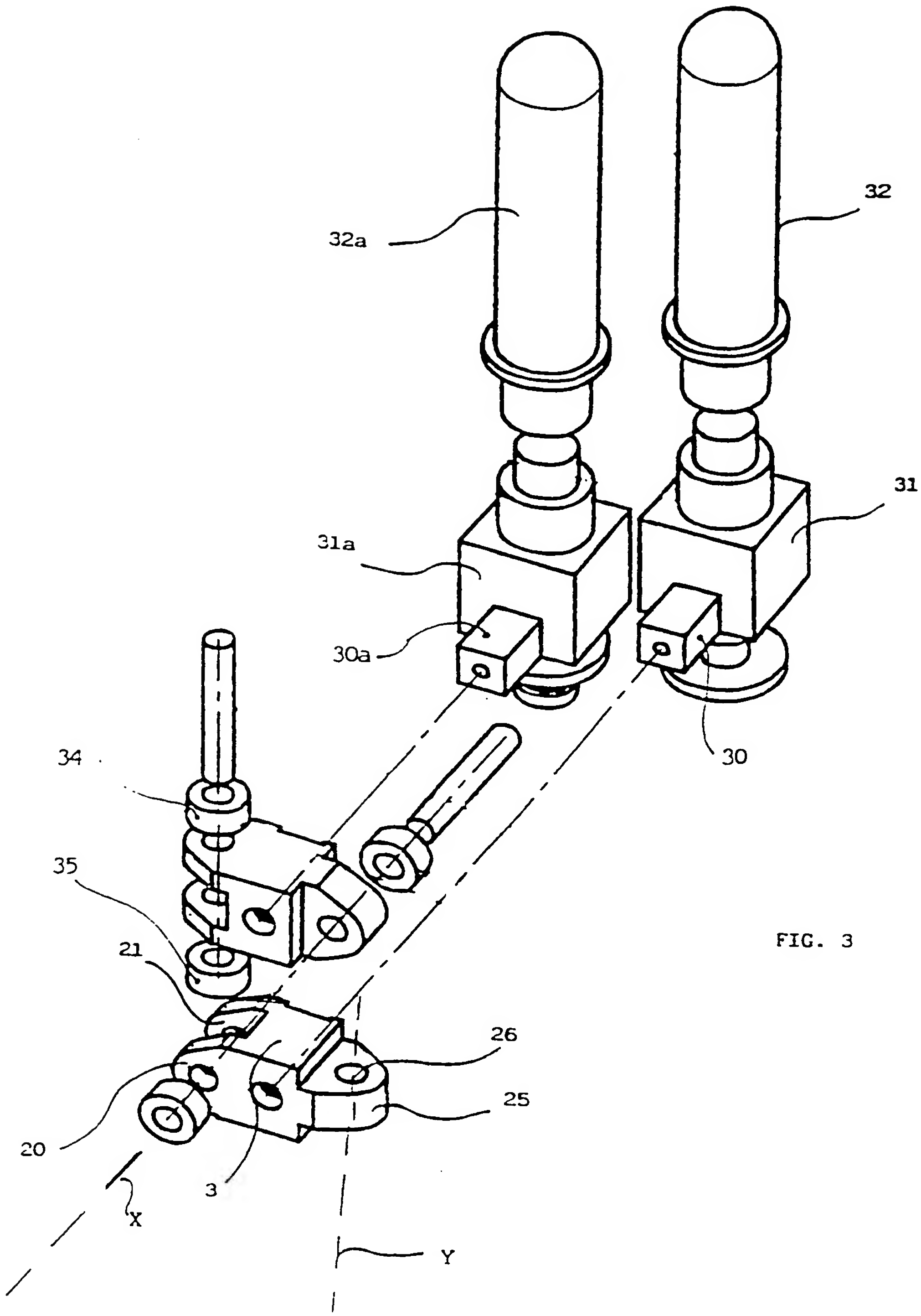


FIG. 3

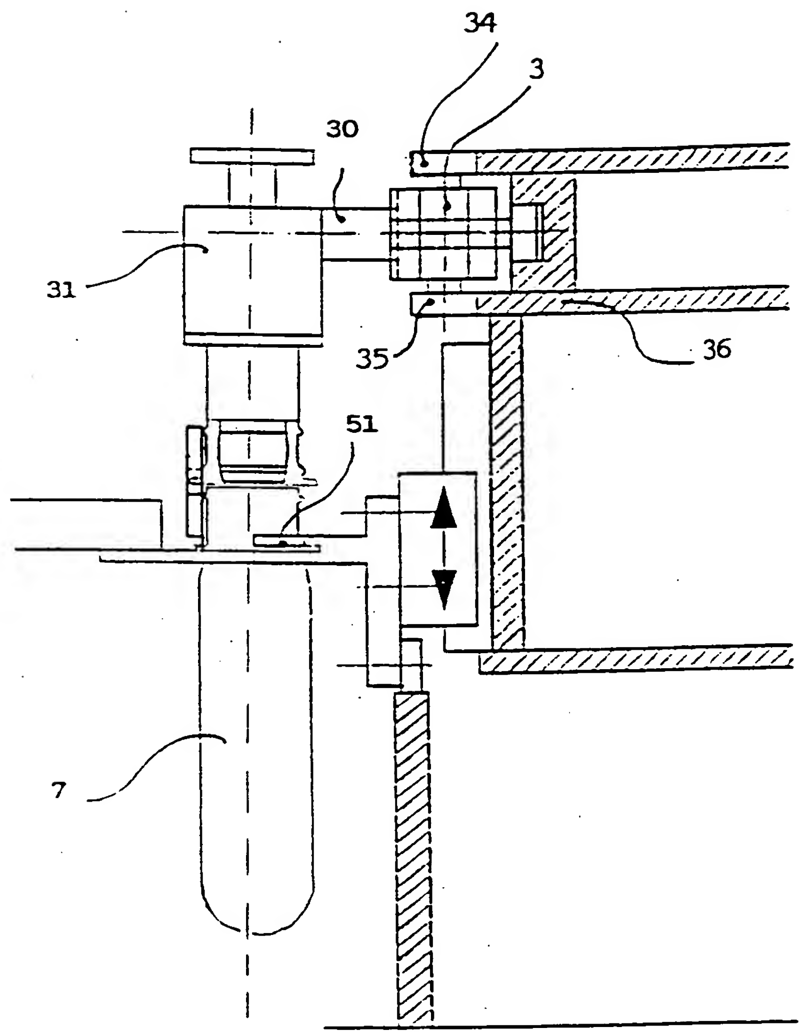


FIG. 4

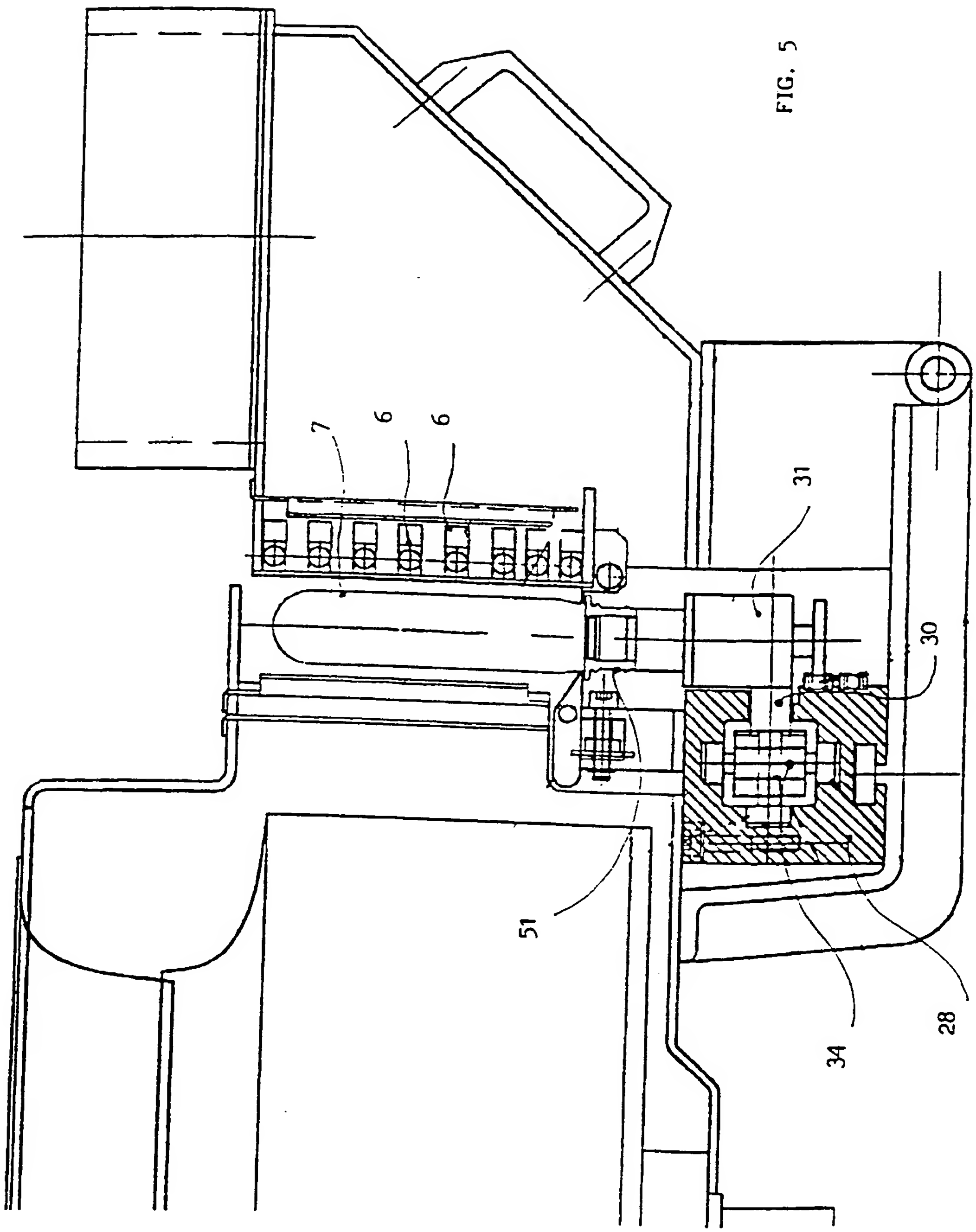


FIG. 5

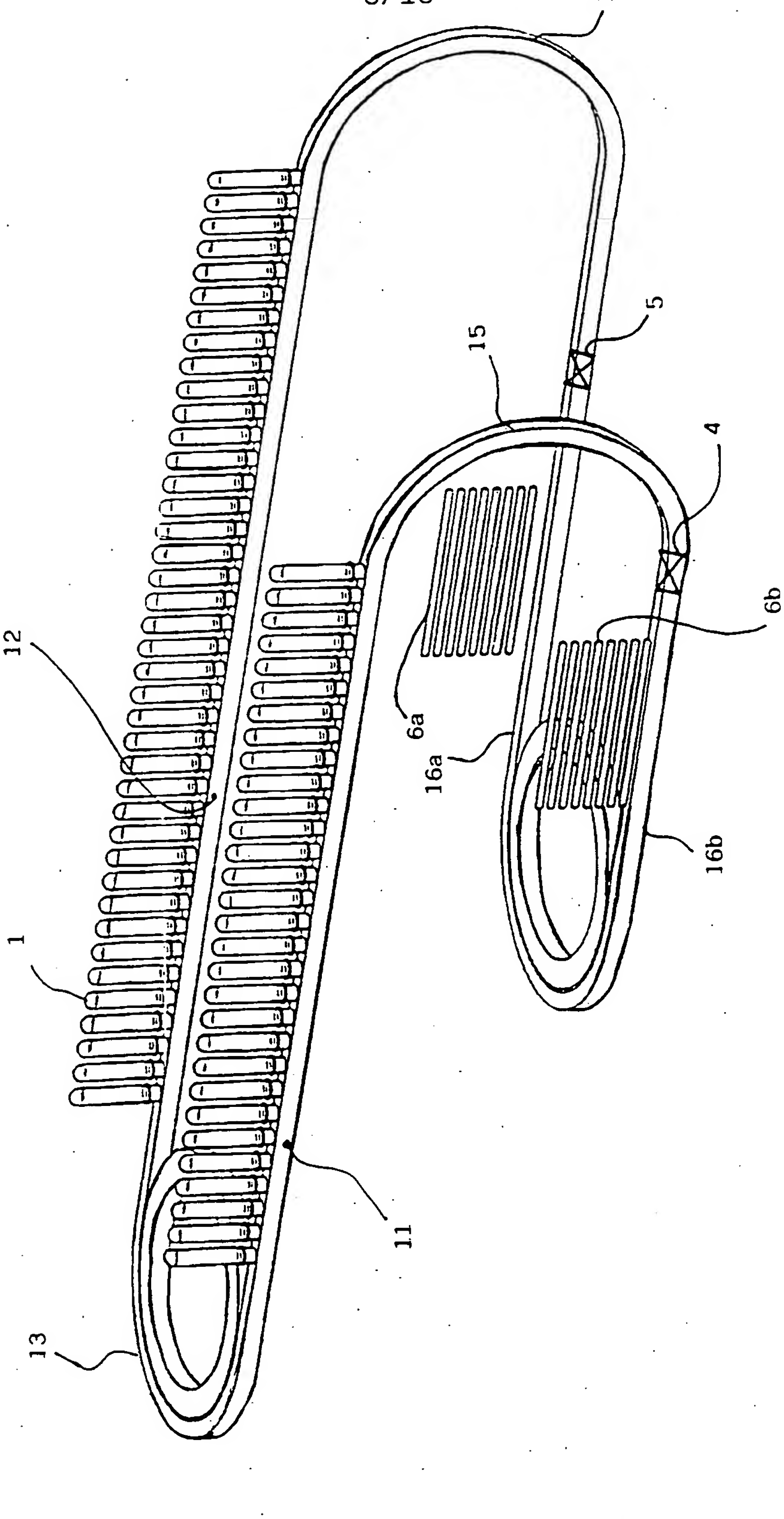


FIG. 6

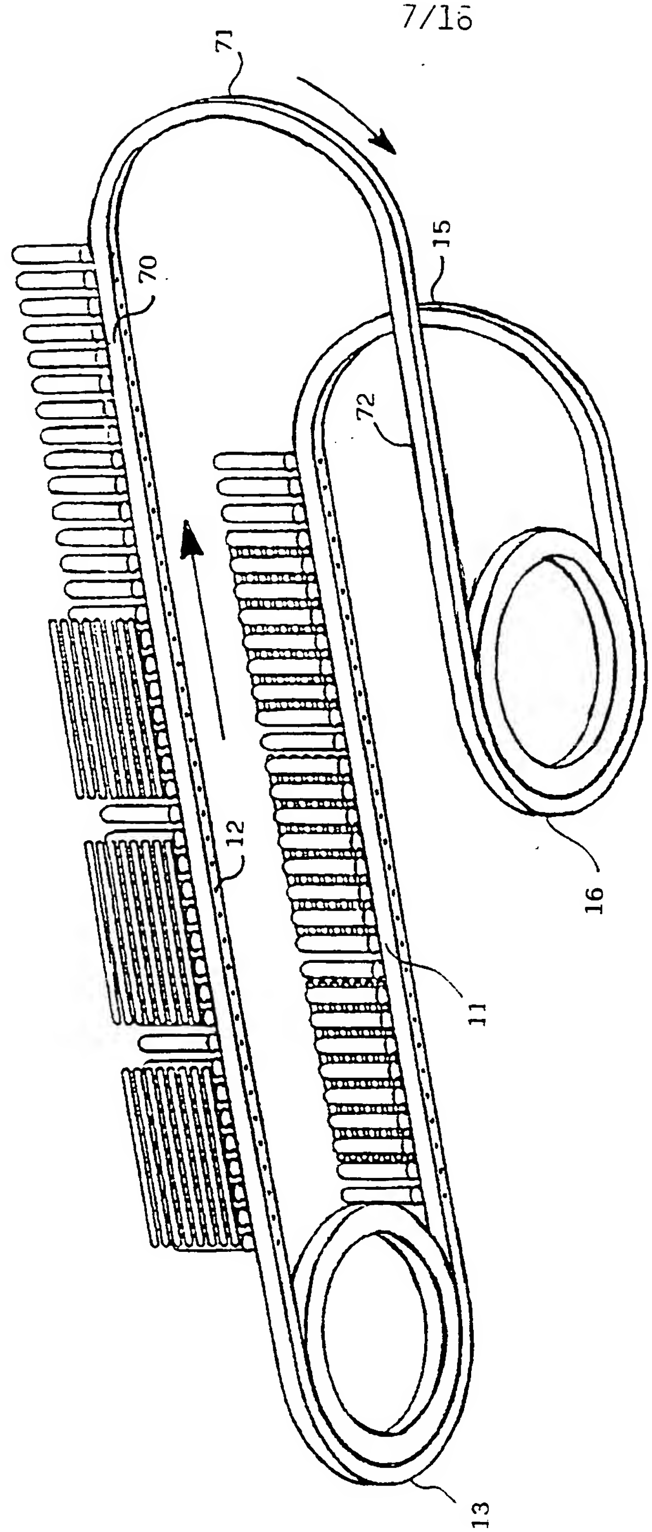


FIG. 7

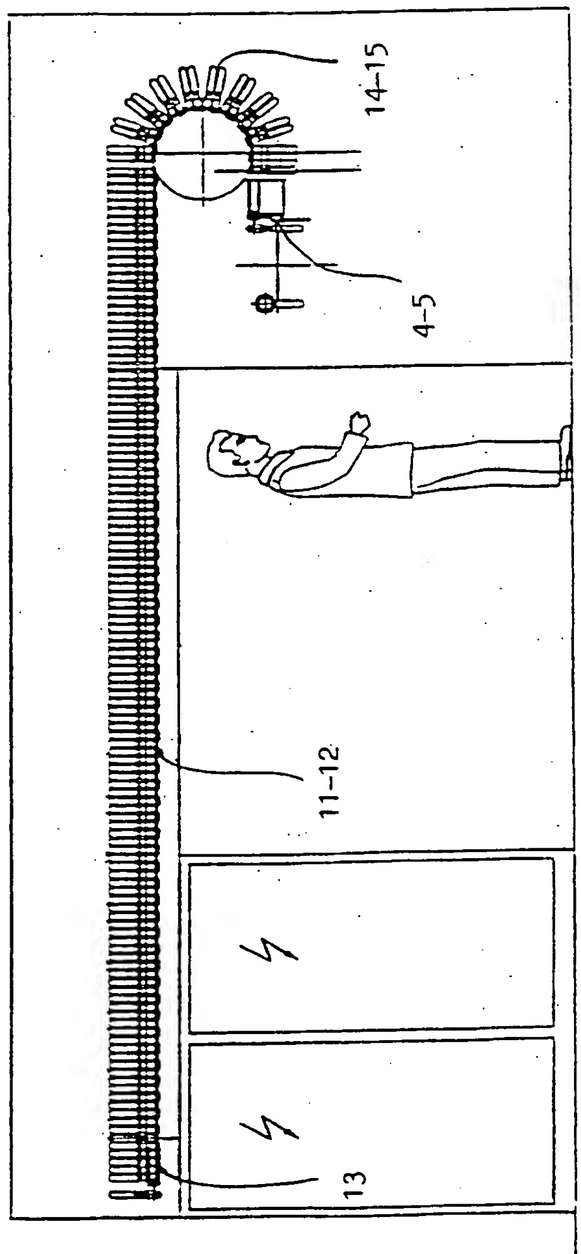


FIG. 8

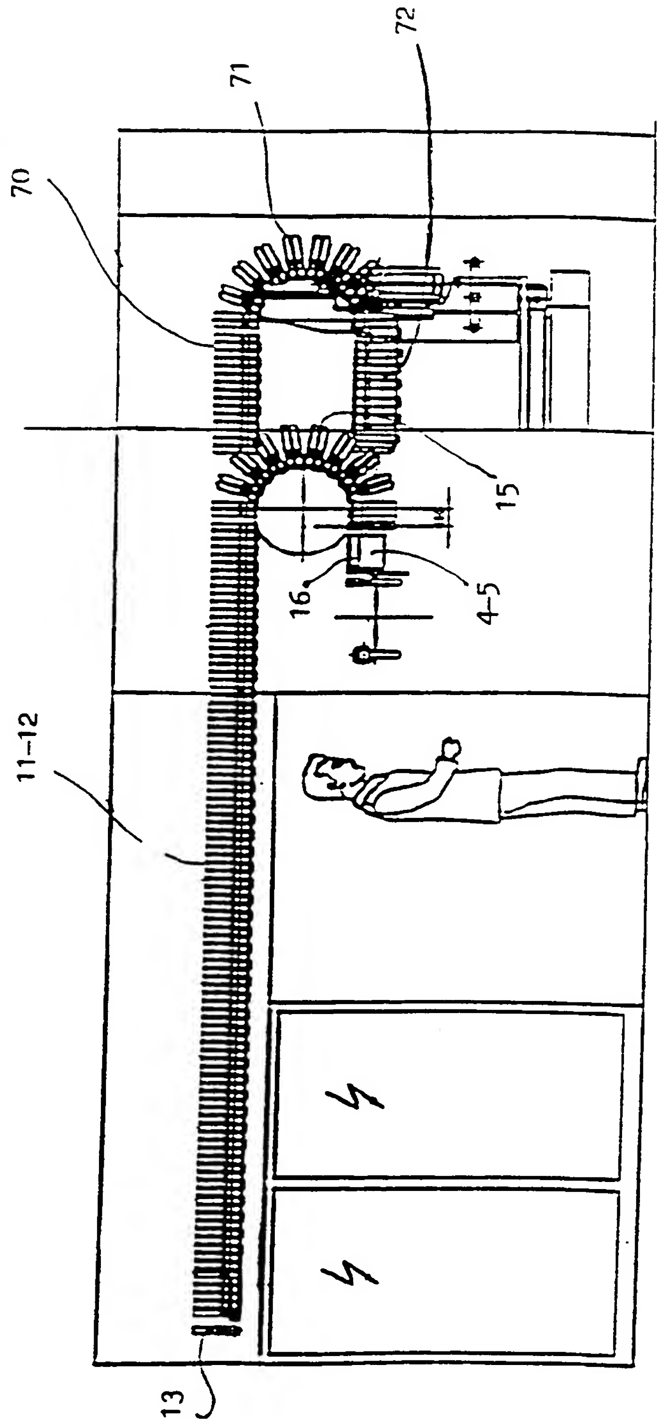
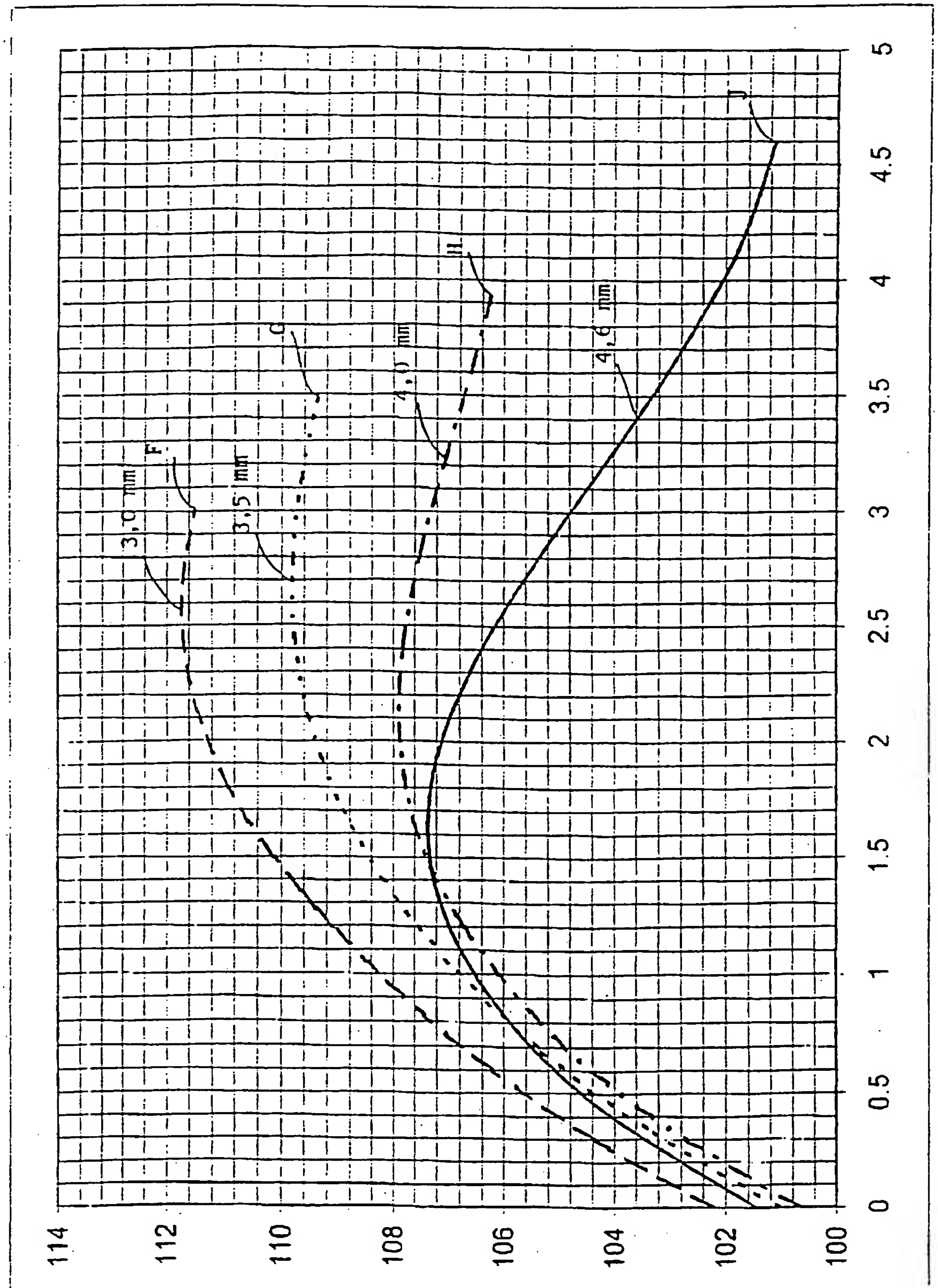


FIG. 9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112
110
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106
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5
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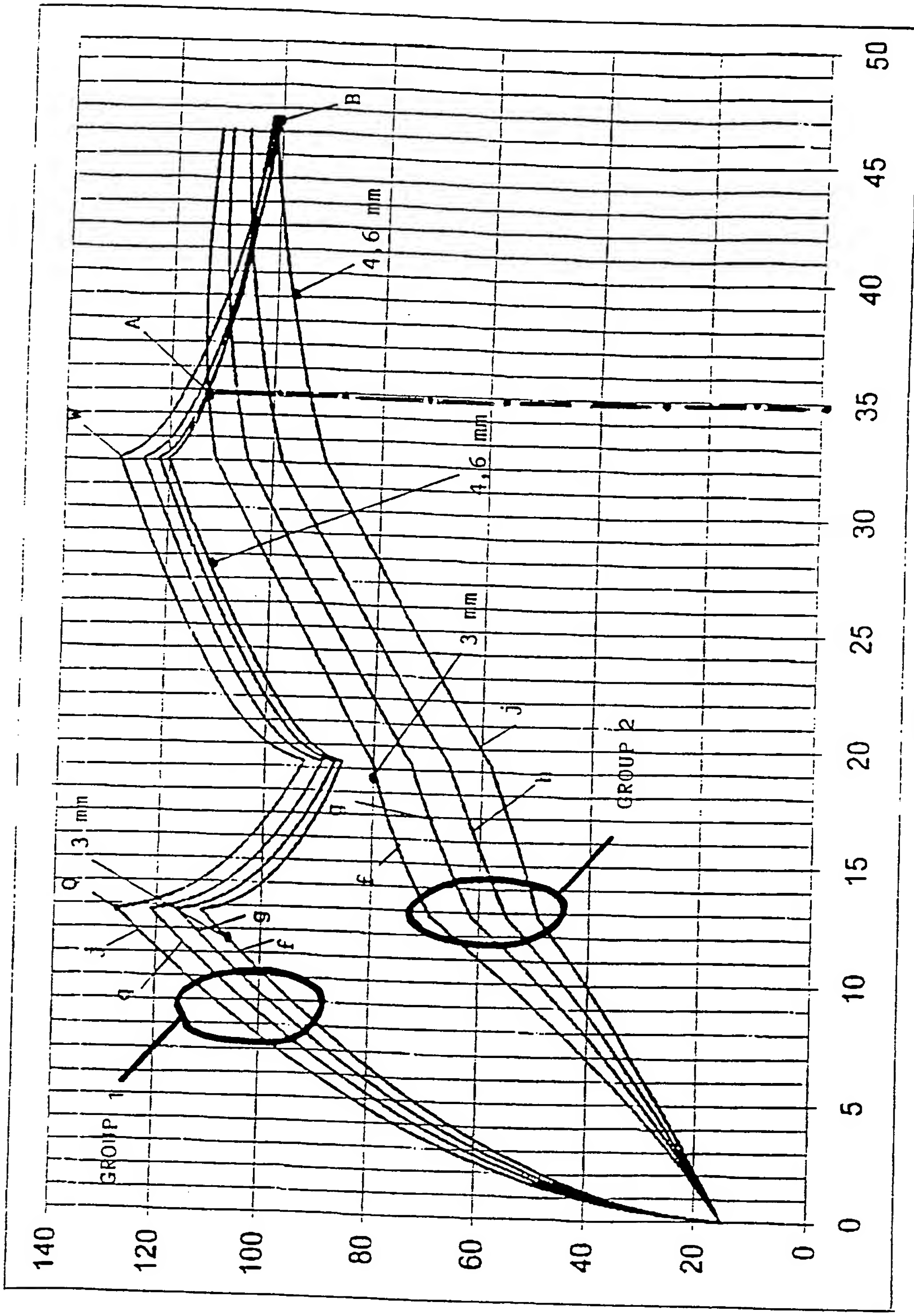
F
3,5 mm
G
4,0 mm
H
4,6 mm
J

FIG. 10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GROUP 2
3 mm
3 mm
4,6 mm
4,6 mm
A
B
Q
f
g
j
l
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120
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5
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20
25
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50

FIG. 11

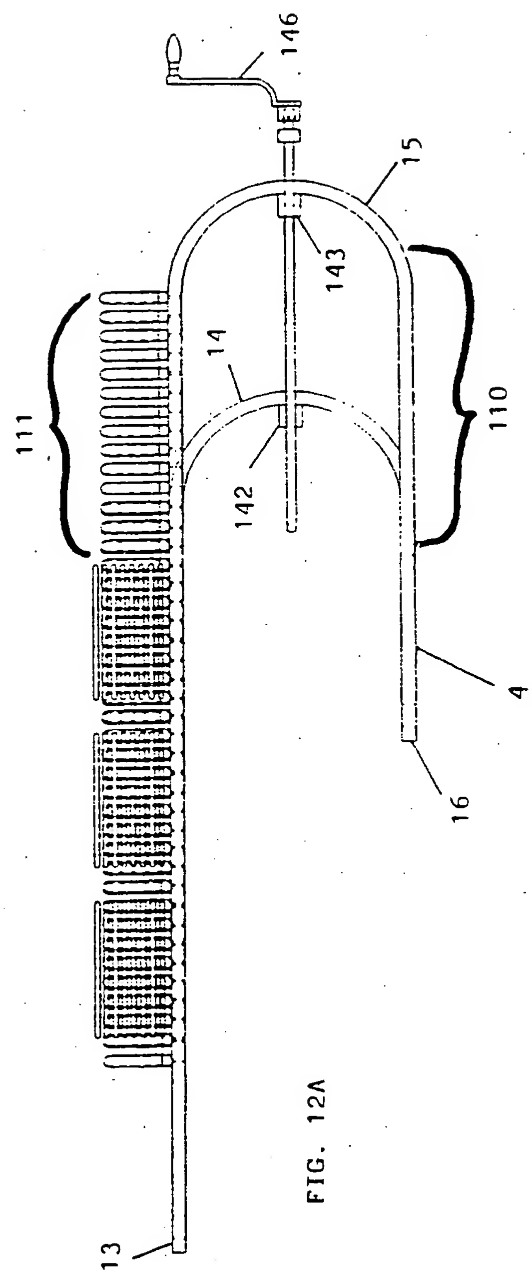

FIG. 12A

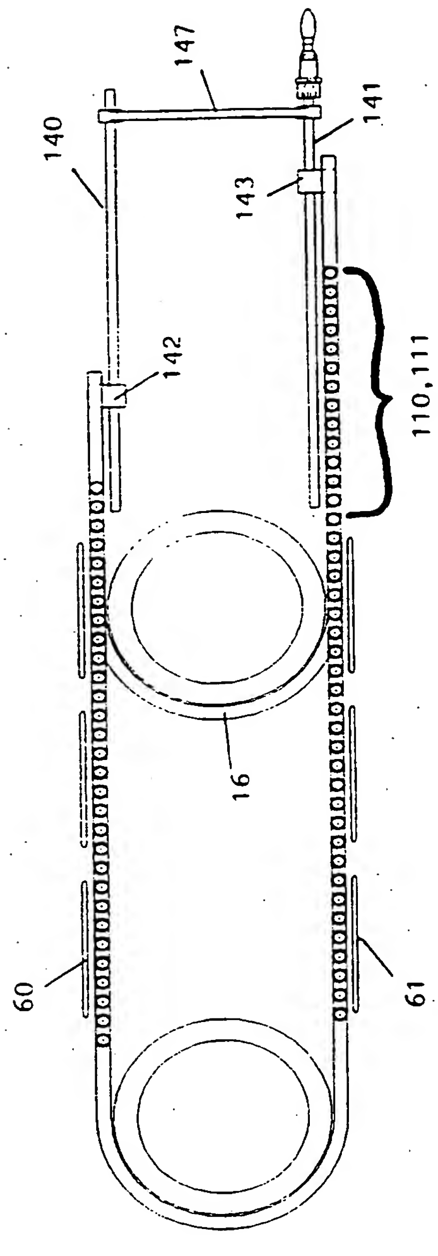

FIG. 12B

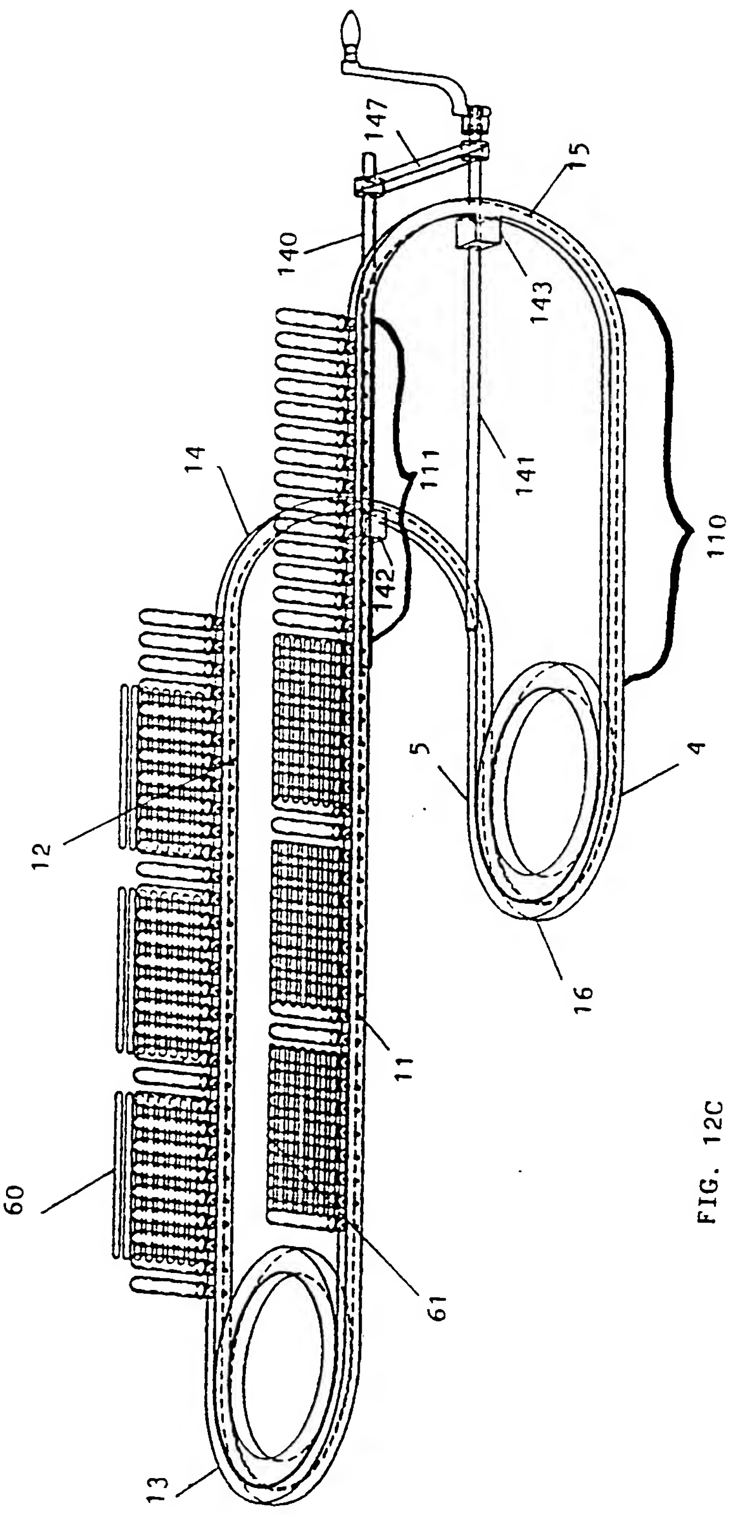

FIG. 12C

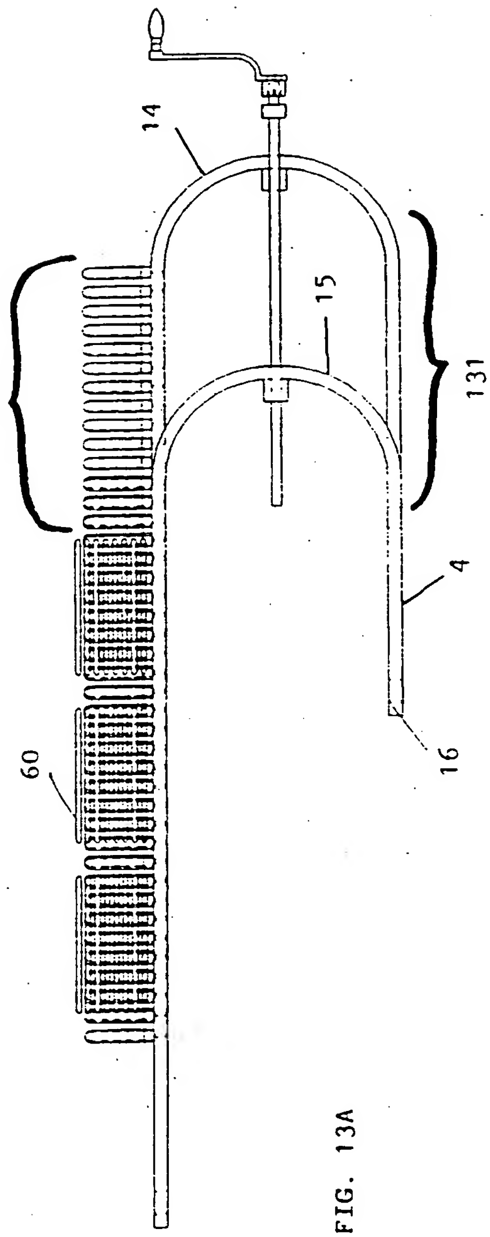

FIG. 13A

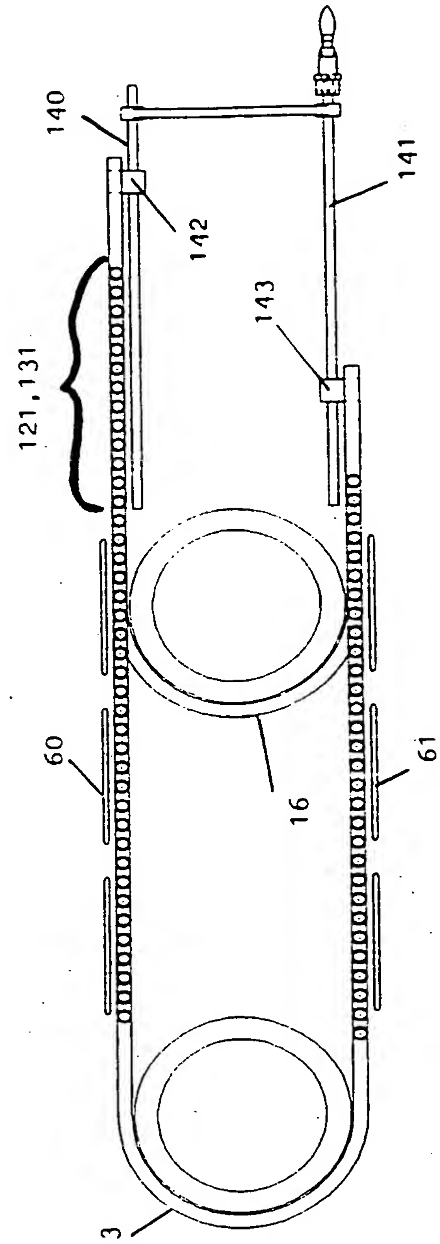

FIG. 13B

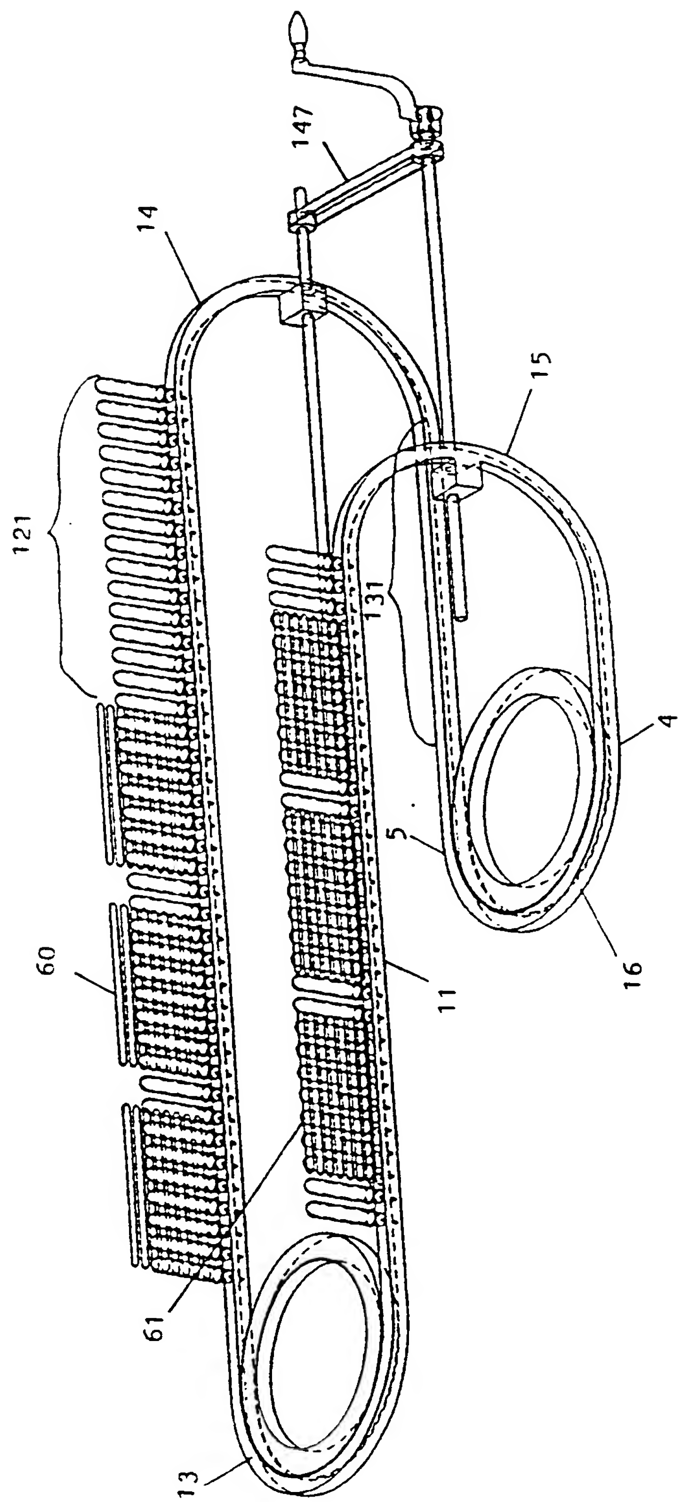

FIG. 13C

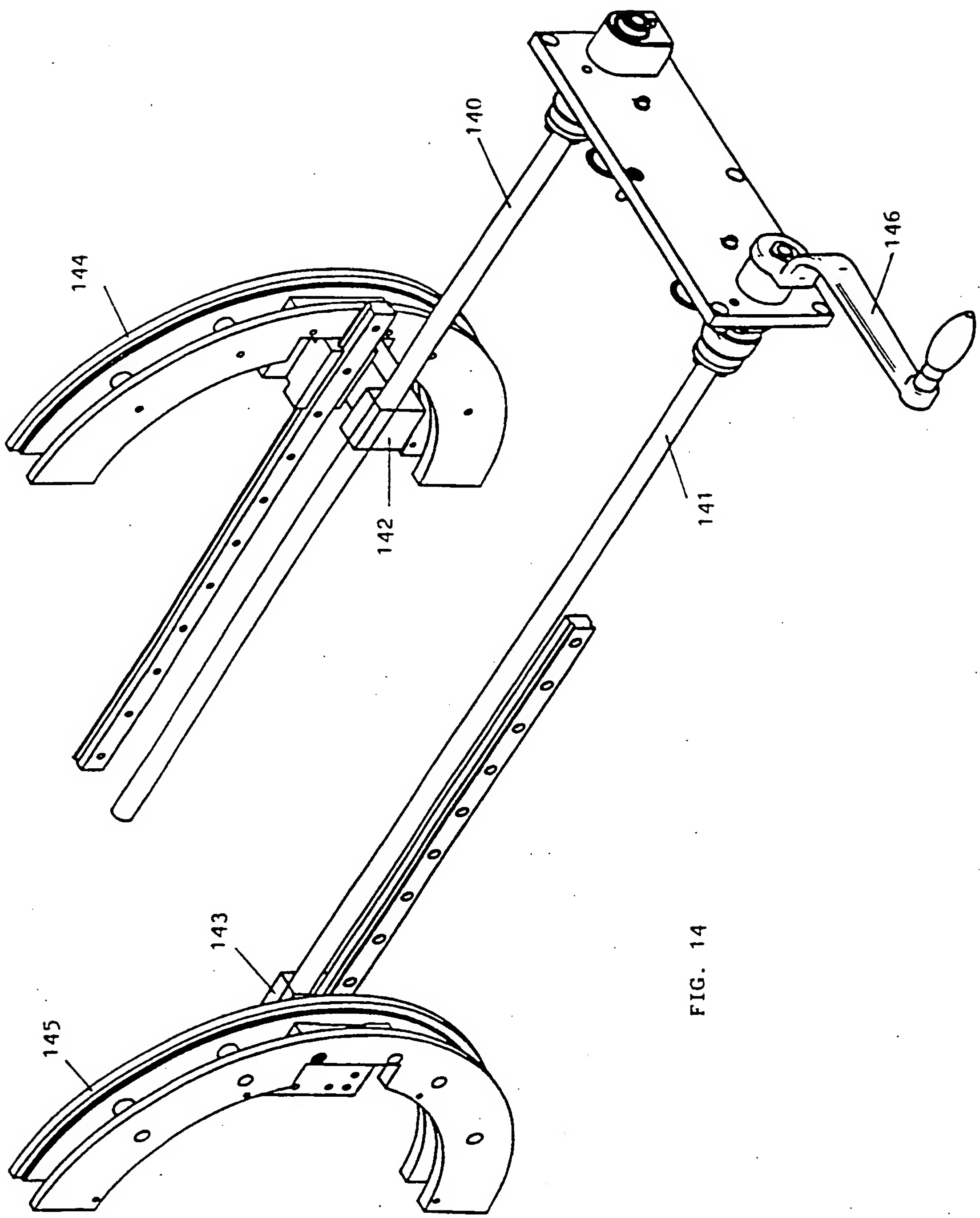

FIG. 14

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 99/03507

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B29C49/64 B29C49/28 B29C31/00 B29C49/42

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 116 217 A (EVRARD ALAIN ET AL) 26 May 1992 cited in the application see column 3, line 31 - column 4, line 6 see abstract; figure 2 ---	1
A	US 4 693 375 A (SCHWEERS KARL D) 15 September 1987 see column 4, line 58 - column 5, line 6; figure 9 see abstract ---	2-6
P,A	EP 0 846 545 A (BEKUM MASCHF GMBH) 10 June 1998 see column 3, line 4 - column 3, line 34 see abstract --- -/--	1-21

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 September 1999	27/09/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Clarke, A

1

International Application No
PCT/EP 99/03507

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	EP 0 888 863 A (NISSEI ASB MACHINE CO LTD) 7 January 1999 see column 10, line 27 - column 11, line 1	7-10
A	US 4 354 813 A (COLLOMBIN ANDRE-MARCEL) 19 October 1982 cited in the application see abstract	15-19

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 99/03507

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